

Claims:

- 1 1. A fiducial apparatus to be inserted into a target region, comprising:
2 a body portion made of a material that is visible using electromagnetic radiation; and
3 one or more anchoring devices connected to the body portion, each anchoring device
4 having an unanchored position and an anchored position, the unanchored position permitting the
5 body portion to move within the target region and the anchored position anchoring the fiducial
6 apparatus into the target region.
- 1 2. The apparatus of Claim 1; wherein the body portion further comprises a radio
2 opaque material so that the apparatus is viewable using electromagnetic radiation.
- 1 3. The apparatus of Claim 1, wherein the body portion comprises a memory metal
2 member that bends in response to an appropriate signal to anchor itself into the target region.
- 1 4. The apparatus of Claim 3, wherein the appropriate signal further comprises an
2 electric field.
- 1 5. The apparatus of Claim 3, wherein the appropriate signal further comprises a
2 predetermined temperature.
- 1 6. The apparatus of Claim 4, wherein the memory metal further comprises nitinol.
- 1 7. The apparatus of Claim 1, wherein each anchoring device further comprises an
2 anchor member and an elastic member connected to the anchor member that urges the anchor
3 member into the anchored position.
- 1 8. The apparatus of Claim 7, wherein the anchor member comprises a spike that
2 embeds itself into the target region.

1 9. The apparatus of Claim 8, wherein the spike further comprises a pyramidal shaped
2 member.

1 10. The apparatus of Claim 7, wherein the anchor member is an elongated rectangular
2 shaped member that embeds into the target region.

1 11. The apparatus of Claim 1, wherein the target region comprises a target region
2 within a human body.

1 12. The apparatus of Claim 11, wherein the target region further comprises a tumor in
2 the body of the patient.

1 13. The apparatus of Claim 1, wherein the body portion further comprises a material
2 that is viewable using an ultrasound image.

1 14. A method for anchoring a fiducial in a target region, comprising:
2
3 inserting the fiducial into the target region, the fiducial having an anchoring device that
4 anchors the fiducial into the target region, the anchoring device being held closed while being
5 inserted into the target region; and
6

1 anchoring the fiducial into the target region after the fiducial is inserted into the target
2 region, the anchoring device opening as the fiducial has been inserted into the target region.

1 15. The method of Claim 14, wherein the insertion further comprises injecting the
2 fiducial into the target region using a needle.

1 16. The method of Claim 14, wherein the anchoring further comprises moving one or
2 more anchor devices into an anchored position in order to embed the one or more anchor devices
3 into the target region.

1 17. A fiducial apparatus, comprising:
2 a body portion; and

3 means for anchoring the body portion into the target region so that the fiducial apparatus
4 cannot move, each anchoring device having an unanchored position and an anchored position,
5 the unanchored position permitting the body portion to move within the target region and the
6 anchored position anchoring the fiducial apparatus into the target region.

1 18. The apparatus of Claim 17, wherein the body portion further comprises a radio
2 opaque material so that the apparatus is viewable using electromagnetic radiation.

1 19. The apparatus of Claim 17, wherein the body portion comprises a memory metal
2 member that bends in response to an appropriate signal to anchor itself into the target region.

1 20. The apparatus of Claim 19, wherein the appropriate signal further comprises an
2 electric field.

1 21. The apparatus of Claim 19, wherein the appropriate signal further comprises a
2 predetermined temperature.

1 22. The apparatus of Claim 20, wherein the memory metal further comprises nitinol.

1 23. The apparatus of Claim 17, wherein each anchoring device further comprises an
2 anchor member and an elastic member connected to the anchor member that urges the anchor
3 member into the anchored position.

1 24. The apparatus of Claim 23, wherein the anchor member comprises a spike that
2 embeds itself into the target region.

1 25. The apparatus of Claim 24, wherein the spike further comprises a pyramidal
2 shaped member.

1 26. The apparatus of Claim 23, wherein the anchor member is an elongated
2 rectangular shaped member that embeds into the target region.

1 27. The apparatus of Claim 17, wherein the target region comprises a target region
2 within a human body.

1 28. The apparatus of Claim 27, wherein the target region further comprises a tumor in
2 the body of the patient.

1 29. The apparatus of Claim 17, wherein the body portion further comprises a material
2 that is viewable using a ultrasound image.

Figure 1 displays 12 histograms, labeled x_1 through x_{12} , showing the distribution of the number of non-zero elements in the vector x_k . The x-axis represents the number of non-zero elements (0 to 10), and the y-axis represents the count (0 to 10). The distributions are roughly bell-shaped and centered around 5, with the peak count increasing from 10 for x_1 to 10 for x_{12} .